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Improving requirement modelling and traceability within an enterprise architecture framework: methods, blueprints and experiences – challenging the DoD AF paradigm

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Abstract

The 1998 UK Strategic Defence Review (SDR) introduced Smart procurement (now Smart Acquisition) to transform both the mechanisms and the values of equipment procurement within defence. This initiative combined a revised procurement process, encouraging novel contractual relationships, and a move to whole-life management. Five years on, the UK's National Audit Office has reported improvements in gross time and cost overrun on major projects, but states that "there is more to do" – further improvements are required in the way that large procurement programmes are managed and run.

In this paper we focus on some areas in which "more needs to be done" and "more is being done" to deliver the SDR vision. The areas addressed include:

- Methodologies and architecture frameworks for defining and managing requirements.
- Engaging, motivating and improving the performance of stakeholders in the acquisition process through transparency, incentive and communication.

This paper summarises, demonstrates and illustrates the methodology and tools that we are developing, and aligns our approach and experiences with improvements in the effectiveness of defence procurement. It argues that the DoD AF paradigm is not sufficient, and that real improvement implies the need for action at both technical and business levels.

1. Introduction

One of the principal outcomes of the 1998 UK Strategic Defence Review (SDR) was the introduction of Smart procurement (now Smart Acquisition), aiming to transform both the mechanisms and the values of equipment procurement within defence, to achieve both cost savings and performance improvements: "faster, cheaper and better". The initiative combines a revised procurement process, with novel contractual relationships and a move to whole-life management to introduce partnering and incremental acquisition, and to control defence inflation.

Five years on, the UK's National Audit Office (NAO), monitoring the performance of the initiative[1], has reported improvements in gross time and cost overrun on the new Smart projects, but notes that "there is more to do". While there are encouraging signs of more innovative relationships with industry, improvements are still required at the basic level of how large procurement projects are managed and run. As noted in the UK NAO report, even Smart projects are £400 million over costs and 61 months over original forecast at Main Gate (see Figure 1 for an overview of the relevant parts of the Smart Acquisition – "CADMID" – process).

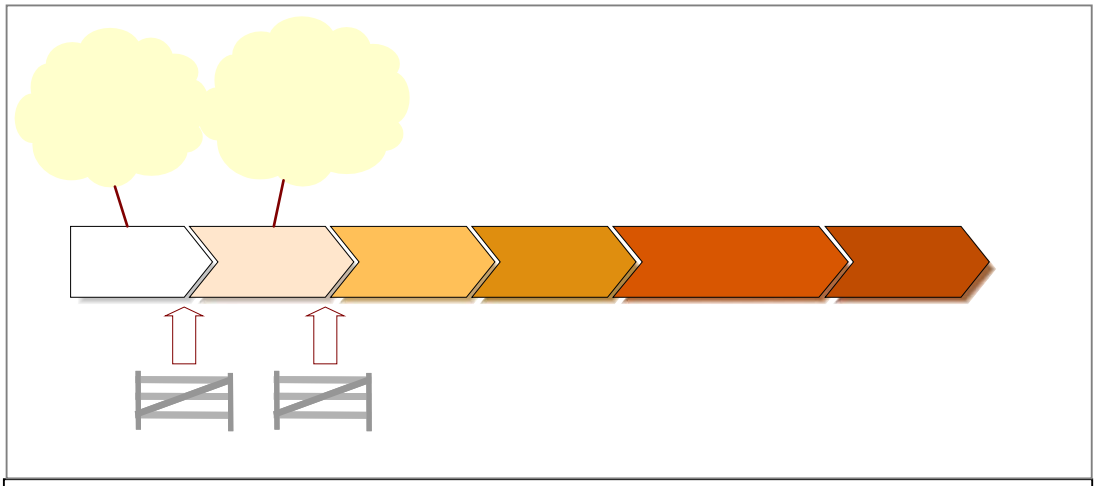


Figure 1. The Stages and review "Gates" within the UK MoD's Smart Acquisition process

In this paper we focus on some specific areas in which "more needs to be done" and "more is being done" to deliver the SDR vision, including:

- Methodologies and architecture frameworks for defining and managing requirements; de-risking development through improved coherence, integration and communication.
- Engaging, motivating and improving the performance of stakeholders in the acquisition process through transparency, incentive and communication.

A pre-requisite for success in large-scale procurement is the definition of expressive and coherent user requirements at the outset, together with a methodology that enforces continued traceability of subsequent development against this. Informal or weak requirements add considerably to development risk, manifest through disconnected design and manufacture activities, in turn leading to ineffective solutions, contractual complications and expensive re-work.

This observation is confirmed in the findings of the UK NAO Report: "*Optimism continues to govern the initial appraisal of projects and there are significant risks that are not always sufficiently understood when committing to the main investment at Main Gate. The costs and in-service dates for more than two thirds of projects have drifted*

User Requirements Definition
- Business Case for Initial Gate approval

[1] UK National Audit Office, "MoD Major Projects Report 2003", Report by the Comptroller and Auditor General, HC 195 Session 2003-2004: January 2004.

away from those planned (50 per cent estimates) towards, and in a very few cases beyond, the highest acceptable approved limits (90 per cent estimates)."

Although a necessary component, this is not in itself sufficient to ensure the levels of effectiveness envisaged within the SDR: there are also important considerations of programme methodology and contract management. The UK NAO Report observes that "*The variations on some Smart projects indicate that there are a range of cultural and systemic influences which the Department and its industry partners need to manage to deliver projects successfully.*"

In this paper we summarise, demonstrate and illustrate the methodology and tools that we are developing, and align our approach and experiences with requirements for improvement in the effectiveness of defence procurement. We argue that real improvement implies the need for action at both technical and business levels, and also that these different perspectives are more closely connected than is generally appreciated. In particular, the development and deployment of enterprise architecture frameworks needs to extend beyond the technical domain if it is to achieve the desired outcome. The US Department of Defense Architecture Framework (DoD AF) is being proposed as a basis for UK improvements. We argue that this in itself is insufficient to deliver the ambitious goals of the SDR because it does not address the real needs for increased business input and engagement within the process.

This paper first describes in more detail the problem space and proceeds to present some observations of shortcomings in current practice. We then describe and illustrate some of the key aspects of our proposed approach, before summarising our argument and presenting our conclusions.

2. The challenges to be addressed

In this section we describe in more detail the problem space that we are addressing in terms of key challenges that must be faced to deliver the SDR goals, and specific requirements that are implied.

2.1 Creating a common language to enable effective engagement of stakeholders

Addressing major acquisition programmes is a fundamentally challenging task, requiring us to manage the evolution and development of an integrated set of common pictures of an enterprise that are meaningful to the perspectives of many different people. These common pictures need to communicate at many levels and in many ways. At one level we need pictures to explain contextual relationships and to set broad expectations of effect; at another level we need pictures that describe the associated "business" stakeholder responsibilities of the programme; and at a much lower level we need pictures that can be subject to analysis of quality and stress.

The complete architecture of any sizeable programme will typically run into many hundreds or even thousands of such pictures. These are of limited (and possible negative) utility unless:

- The pictures really are integrated – in that they fit together so that changes in one perspective or at one level ripple through other aspects of the architecture that is affected by the changes.
- The pictures really are common – in that they enable a single understanding to be communicated across the communities of stakeholders, where changes initiated by one community are reflected in the other perspectives.
- The pictures address the breadth of perspectives needed to synchronise and co-ordinate the development of the required capability.

Imagine looking at something from 60,000 feet. Then change your perspective so you see just part of this picture from 6 feet. A representation that works for components that are a long way off may not work when trying to understand the detailed requirements for integration of this component with other equipment in the field (see Figure 2).

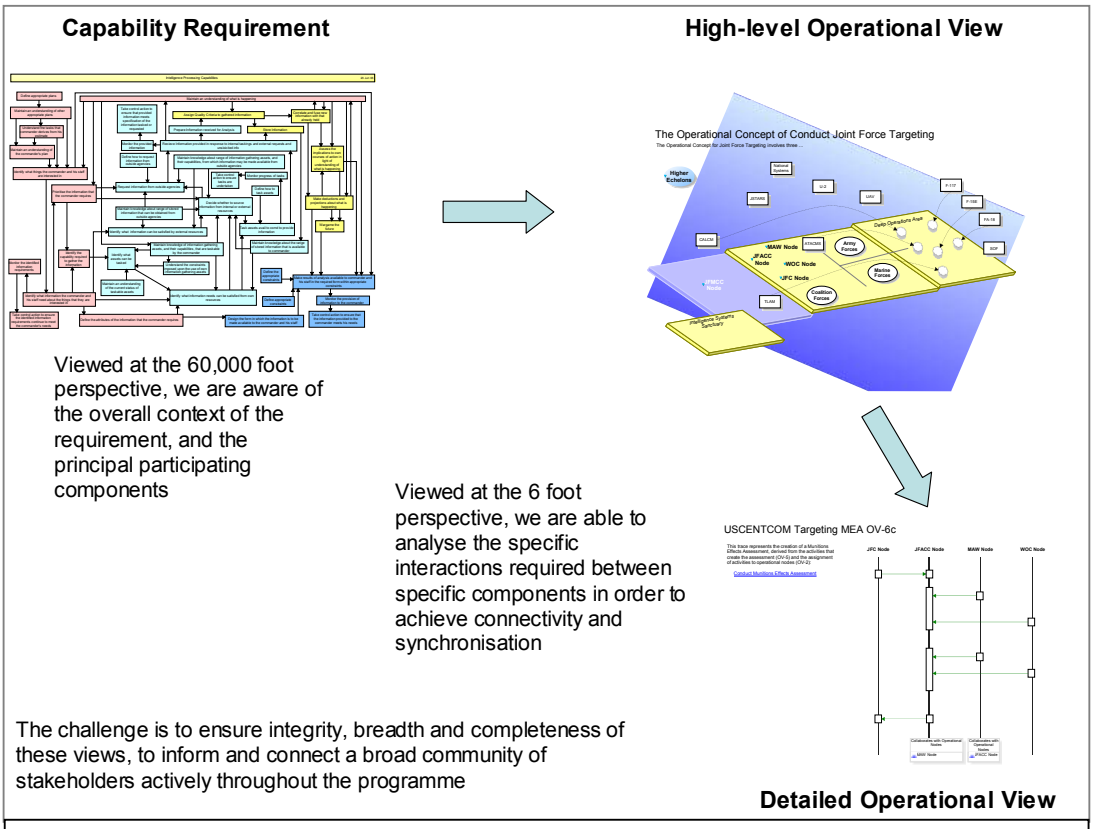


Figure 2. The challenge of achieving a single consistent picture that is meaningful to diverse stakeholders

Moreover, these perspectives need to be accessible and meaningful to a wide range of stakeholders, including people whose interests cover technical, commercial, contractual and managerial aspects of development. For example, it is critical to provide a perspective to allow training requirements to be assessed at an early stage to avoid delays on achieving an operational capability.

The UK NAO Report observes that "*Successive Major Projects Reports since 2000 have highlighted the need for the Department to get the best out of the crucial early Assessment Phase of projects in terms of understanding and reducing risks*."

Methodologies and notations for describing and analysing requirements must not therefore focus solely on technical perspectives; otherwise we embed at an early stage the risk of key stakeholders becoming disengaged from crucial decisions. Consequently, the original vision is lost, together with the crucial responsibility for defining key aspects of the required effect. This disengagement is a common cause of delays and expensive re-work later in the process. It is a significant contributor to the UK NAO's observation that "*risks are not always sufficiently understood when committing to the main investment at Main Gate."*

To keep key stakeholders engaged through the crucial early stages of the procurement process, it is necessary that these stakeholders are able to work with the collection of pictures in an intelligent and absorbing way, and also that these stakeholders take the clear responsibility for defining what it is that they need.

The challenges introduced above have diverse implications. These are summarised below in terms of three key requirements for improving the effectiveness of defence procurement:

2.2 Defining capability requirements independently of solution

- We need a process for managing User and System Requirements that is meaningful to the owners and stakeholders of the system, while at the same time sufficiently rigorous to enable analysis.
- This process needs to enable agreement and debate on the overall vision for the capabilities in the enterprise, with all of the richness around where the enterprise is now and where it is heading.
- We need to be able to manage requirements as a set of principles and constraints that exist through the lifetime of a set of capabilities rather than as a contractual statement created by and for the benefit of technicians and experts.
- We need to support informed Balance of Investment decisions such that the impact of those decisions on the delivery of military capability is fully understood. This requires an understanding of the interdependencies of individual requirements and their contribution towards the delivery of a particular capability.

2.3 Managing communication and relationships

- We need to understand the contributions of and relationships between the key stakeholder groups of specifier, customer (or end user), procurer and supplier in capability development and delivery.
- We need an environment in which both the military and industry stakeholders can communicate and share throughout the procurement process at all levels from vision through to design.

- This environment needs to provide a mechanism whereby these stakeholders keep sharing and interacting through the lifetime of the components that are acquired and developed.
- We need to understand the difference between relationships that are about on-going service provision and those that focus upon development and handover of capability, and manage these accordingly.

2.4 Managing performance and achievement

- We need to be able to define performance across all the views, across all components, whether these are technological, organizational, process-based, role-specific, military capabilities or pieces of equipment, including performance-based interaction between these.
- We need to be able to define metrics that apply to service and network-enabled capability concepts such as interoperability.
- We need to be able to monitor and tune the performance of the parts and the whole over time.
- And we need to be able to address all of these issues without burdening the development process with unacceptable cost, complexity or effort overheads.

3. Shortcomings in Current Practice

In this section we consider several key aspects of current practice within the context of the challenges and requirements identified previously. We address four specific aspects.

3.1 Requirements definition is conditioned by current & past assumptions

User requirements are too often developed within the assumptions of current experience. This means that at the outset, a new capability is assumed to be a strike aircraft, a frigate or an armoured land vehicle.

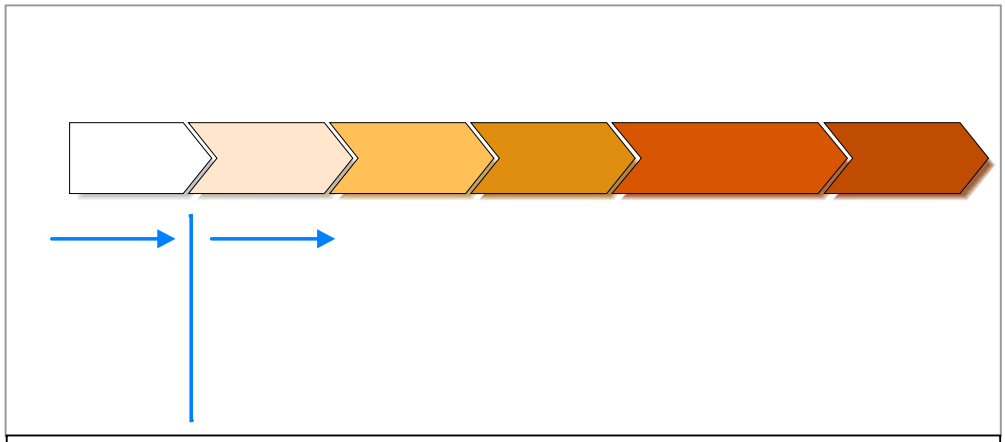


Figure 3. The need for concept development independent of technical solution

The consequences of this tendency are that:

- At the only point in the process where there is licence for this breadth of innovation, creative alternatives are not explored;
- Requirements are prematurely expressed in terms of the technical solutions previously applied for that kind of equipment, further limiting the opportunities for innovation (see Figure 3).

3.2 The coverage of key areas within acquisition stages is often unbalanced

Each stage in the acquisition process involves considerations of various kinds, including the technical, the organisational, performance, people & training, and others. Each of these is significant to one or more of the stakeholders participating in the process.

The coverage of these considerations is often unbalanced, with more focus in certain areas than in others (See Figure 4.)

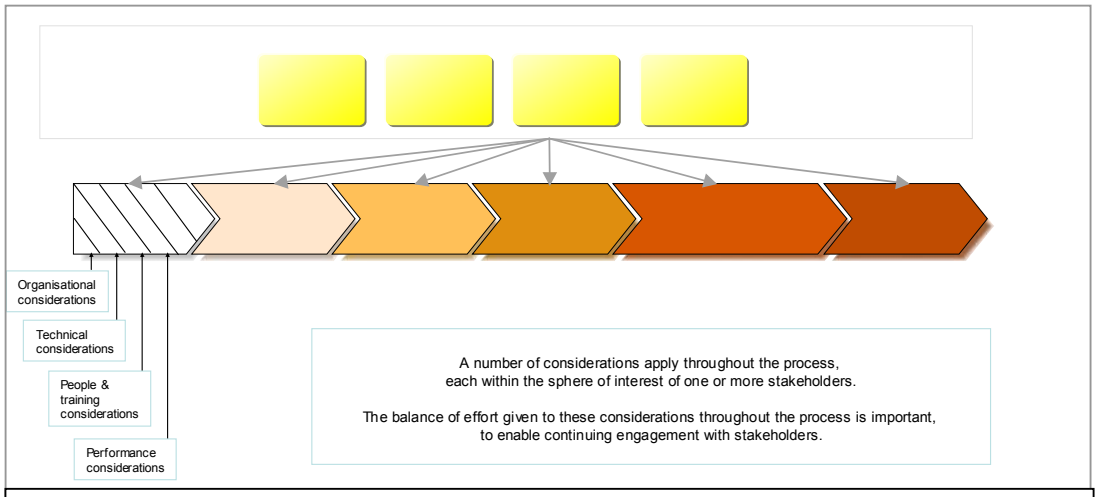


Figure 4. The need to balance the effort applied to different considerations in order to sustain stakeholder engagement

An example of shortcoming in this area relates to the UK Apache programme which, following difficulties in the delivery of training services, will not now be completed until February 2007, nearly 3 years later than expected. Some Apache aircraft will have to be stored until trained pilots are available to fly them, at an additional cost of £6 million[2].

3.3 Application of enterprise architecture methodology over-emphasises the technical

Enterprise Architecture Frameworks in general, and DoD AF in particular, have emerged in response to these kinds of challenges. Although the concepts have been in the public domain for many years (see, for example, the original work of Zachman[3]),

2 Ministry of Defence, "*Building an Air Manoeuvre Capability: The Introduction of the Apache Helicopter*", Report By The Comptroller And Auditor General HC 1246 Session 2001-2002: 31, October 2002

3 John Zachman, "*A framework for information systems architecture*", IBM Systems Journal Vol 26 NO 3, 1987

this initiative has been given extra impetus in the US by the 1996 Clinger Cohen Act. Recognising the promise of this approach, interest in the UK is accelerating.

Enterprise architectures put together the process to be followed, the products to be created and the way these are to be used in such a way as the whole acts as an anchor for a development programme. The resulting structure is intended to be used as the basis for planning and decision making on an on-going basis. Gartner have cited three main justifications for enterprise architecture:

- Saving costs through standardisation and reuse.
- Allowing the improvement of business processes.
- Allowing for strategic shifts in business relationships.

The scope implied by these justifications is broad and consistent with Zachman's original vision. However, the potential benefits of this approach have proved elusive because the approach poses many of the challenges described above and these have not fully been grasped. All too often enterprise architecture initiatives create different perspectives on one project, rather than facilitating different perspectives across one enterprise containing multiple projects. As one recent commentator working within the UK MoD has observed:

> "Creating individual models and diagrams is not the hard part for architecture – in practice we tend to know already what many of the components are. It's getting these components to fit together, allowing individuals to apply their own expertise yet help to make sense of the whole that is the real challenge. Only by meeting this challenge head on can we be in a position to evolve our systems and our organisations sufficiently rapidly to achieve the kind of agile capability that the modern world of defence demands."

In other words, for enterprise architectures to be effective, it is important that both the methodology respects the real requirements of the enterprise, and that the methodologies and tools used to create and manage the architecture allow the kinds of coherence of expression and analysis that we need in order to address the real challenges.

3.4 The social and economic realities of acquisition are being neglected

Smart Acquisition and Enterprise Architecture Frameworks offer attractive management metaphors for defence decision-makers. But these metaphors do not make decisions and they cannot be evaluated without reference to the motivations and behaviour of individuals and groups who use these systems. Here, the economics contribution focuses on the principles of self-interest and the pursuit of beneficial exchange; it identifies some of the major differences between the public and private sectors of the economy; and it shows the role of uncertainty and the costs of contracting[4].

Efficiency in the private sector results from competition, the pursuit of profits by entrepreneurs and the role of the capital market as a 'policing and monitoring'

4 Sandler T and Hartley K, "*The Economics of Defence*", Cambridge University Press, Cambridge, Chapter 5. 1995.

mechanism. These institutions and incentives are absent from the public sector. In defence, there are no rival Armed Forces, there are no military entrepreneurs and there is no capital market with its threats of take-over and bankruptcy.

Smart Acquisition and Enterprise Architecture need to recognise that they involve various interest groups, each pursuing different objectives. In itself, use of these metaphors does not guarantee that people will work together. In effect, the approaches create a complex and adaptive set of human relationships with massive opportunities for conflicting objectives. For example, Smart Acquisition embraces interest groups of the Armed Forces, the Ministry of Defence and private contractors (some of which might be non-UK firms). The Armed Forces require modern equipment at affordable prices (given limited defence budgets); the UK MoD seeks 'best value for money' which includes narrow defence criteria as well as wider industrial and economic benefits associated with procurement; and contractors are seeking profits. The challenge is to recognise these conflicting objectives and devise contractual arrangements that will provide the buyer with efficient solutions. Even this simple statement of the procurement problem is not without its difficulties. Who is the buyer (the Armed Forces or the MoD); how is efficiency defined and by whom; which type of contract will achieve these objectives; and how are contracts to be awarded (competition vs. negotiation)?

It also has to be recognised that procurement choices take place in a world of uncertainty where no one knows the future. This is particularly the case in defence procurement where there are major uncertainties about both technology and the future threat often involving time-horizons of 40-50 years (e.g. Trident; Typhoon). Uncertainty also means that contracts are incomplete since it is not possible to write a complete contract which anticipates all future contingencies (some are unknown and unknowable).

Smart Acquisition and Enterprise Architecture are not costless systems. Like all contracting, they involve substantial transaction costs and there are always possibilities of unexpected and perverse outcomes. People adjust to organisational and policy changes and can play any games. Transaction costs include the costs of search, negotiation, agreement, monitoring and enforcement of contracts; and since no agreement can specify all possible future contingencies, changing contractual agreements involves substantial transaction costs[5].

Contracting is characterised by opportunism and 'bounded rationality':

- *Opportunism* recognises that individuals and groups will take advantage of situations, especially when the terms of a contract are vague or missing. For example, individuals might have incentives to hoard valuable information and such hoarding can disrupt information flows both within and between organisations and agencies.
- '*Bounded rationality'* recognises that no contract can cover every contingency in an uncertain world: people have bounded rationality in the form of a limited ability to specify all future possibilities (states of the world).

5 Arrowsmith S and Hartley K (eds), "*Public Procurement*", International Library of Critical Writings in Economics 144, Elgar, Cheltenham. 2002.

Private firms use incentives to encourage efficient behaviour and to reduce internal monitoring costs (e.g., performance-related pay; bonuses; prizes, etc). Competition and the capital market also provide efficiency incentive. Ultimately, entrepreneurs have to take risks and make decisions and success is rewarded with profits and failure results in losses and possible exit from the industry. There are no such efficiency incentives, mechanisms and entrepreneurs for the MoD and Armed Forces.

The implication of an economics approach to Smart Acquisition and Enterprise Architecture is that there are no perfect solutions. All organisational arrangements are flawed. The challenge is to select arrangements which minimise the flaws and inefficiencies. Here, there are some economic principles offering policy guidelines:

- First, competition promotes efficiency amongst contractors.
- Second, successful contractors need to be subject to efficiency incentives in the form of an incentive type contract (target cost incentive or firm/fixed price contracts).
- Third, the procurement agency needs to be clear about its policy objectives; about the 'weights' it attaches to various and often conflicting objectives; and it need to recognise that in an uncertain world, these objectives and hence equipment performance requirements can change and need to change.

Competition can only be promoted if the competing elements can be adequately described and understood. Unlike competing solutions, concepts, policies and incentives cannot so readily be described. And this is an area where Enterprise Architectures have a valuable contribution to make: assisting in the formalisation of these relatively intangible elements, revealing insights about the choices available, as a basis for rational exploration and discussion.

4. Addressing the challenges: methodology, notations and tools

Implementing these principles and addressing the other challenges for acquisition set out in this paper requires thinking rather differently about methodology, notations and tools than their historical background and heritage currently allows. In this section we introduce the elements of our approach to the challenges introduced in the previous sections, and describe its application to a current area of capability development.

4.1 Principles and ideas underlying the approach

The creation of methodology, notations and tools to support acquisition and development has become a significant industry in its own right over the past three decades, drawing influences from a variety of sources, such as operational research and software development methods. The approaches that have been developed have been predominantly technical, based on semi-formal diagramming notations from the computing and telecommunications communities.

While meeting with a degree of success in addressing the more formal development activities, these methods and tools have been found lacking when the process of development and acquisition is considered from a whole-process point of view that encompasses social and economic realities. Objections revolve around the

observation that the acquisition process is ultimately all about people interacting with other people, coming to a shared and joint understanding of the situations in which they each hold authority.

This key observation, memorably described by Goguen[6] as the need to reconcile the 'wet' with the 'dry' in this process, has not received the recognition that it deserves in defence acquisition, despite the groundwork being laid out through the Smart Acquisition's CADMID process which lays the framework for the stakeholders, stages and perspectives that need to be accommodated and supported individually, and in interaction with others.

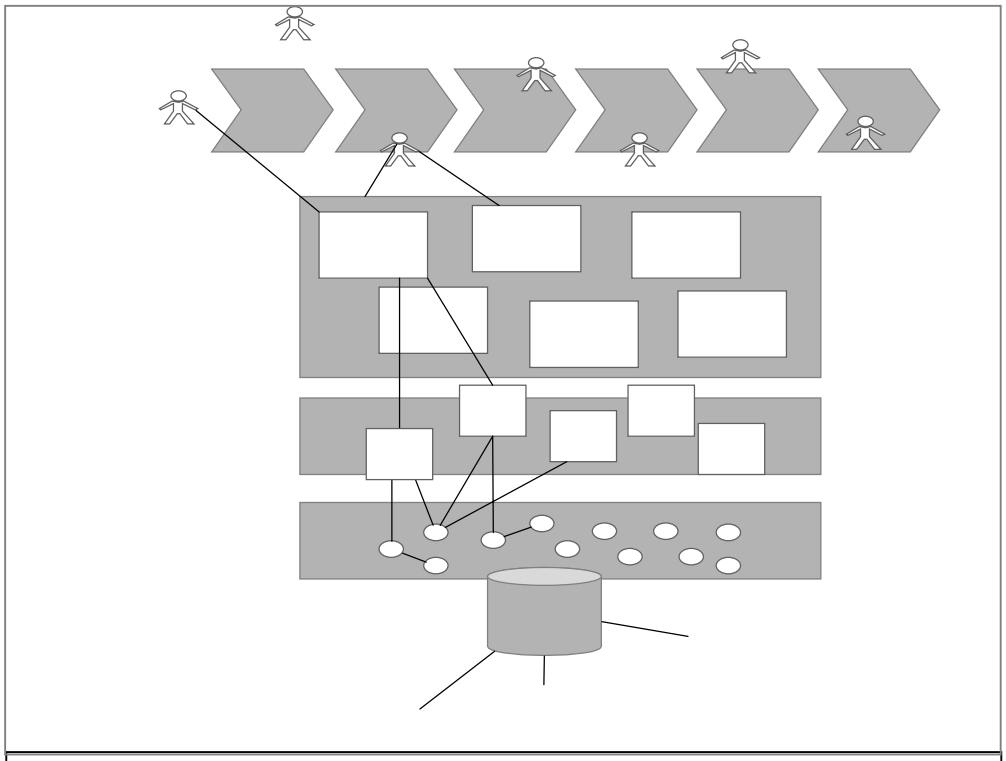


Figure 5. Multi-layer requirements for engagement of stakeholders

The approach the authors have taken in addressing these challenges has been to deploy Salamander's MooD® Transformation Toolset to create a US DoD AF based *Transformation Blueprint* that encompasses operational, systems and technical standards views, plus additional capability and acquisition views, integrated through an open underlying repository. The toolset has been developed over the past seven years by a team combining experience in operational research, formal requirements engineering, software development and operational and business strategy, and has been applied in a wide range of modelling applications spanning many industries, across many stakeholder communities, uniting different aspects of business and technical development and acquisition problems.

Allied to a strong and flexible underlying repository, the MooD toolset has enabled the team to develop a blueprint with the ability to display the key themes of

6 J Goguen "*The Dry and the Wet*" Technical Monograph PRG-10, Oxford University Computing Laboratory, 1992

integration and coherence across the changing needs of the acquisition process, as it progresses from the contextual and exploratory to the deeply technical and contractual.

The blueprint acknowledges the different stakeholders and enables the perspectives they require, at the same time as building reusable catalogues of components, whether these components are technical, contractual, organisational, or simply requirements or effectiveness envelopes that occur throughout and across different capability needs and projects.

The enabling platform for the approach is a technical innovation within which a toolset of notations allow common elements to be put together for particular purposes, and where each contextual reuse of an element contributes to a richer definition of that element when viewed across the range of perspectives (see Figure 5). This feature enables different stakeholders across the process to be engaged on their terms, but connected to the work of other stakeholders at other stages.

Two key points have arisen from our work across the communications capability, illustrated here by examples from Air Manoeuvre Command and Control (C2), one of the projects that the authors have been working with in the early stages of CADMID.

4.2 Support throughout the acquisition process, not just at development and manufacture

The development of User Requirements for an Air Manoeuvre Command and Control System in the Land and Littoral environment requires understanding a range of different concepts concerning the context of operations and how these fit together.

The approach that we have taken involves recognising the concepts being used – including organisations, defence tasks and capability, environments, performance profiles and so on – and allowing these to be captured directly in appropriate models that allow the stakeholders involved to both express and validate the concepts in a familiar and accessible format.

The Defence Capability Framework (see Figure 6) is used extensively to explore and reconcile this range of business and technical views.

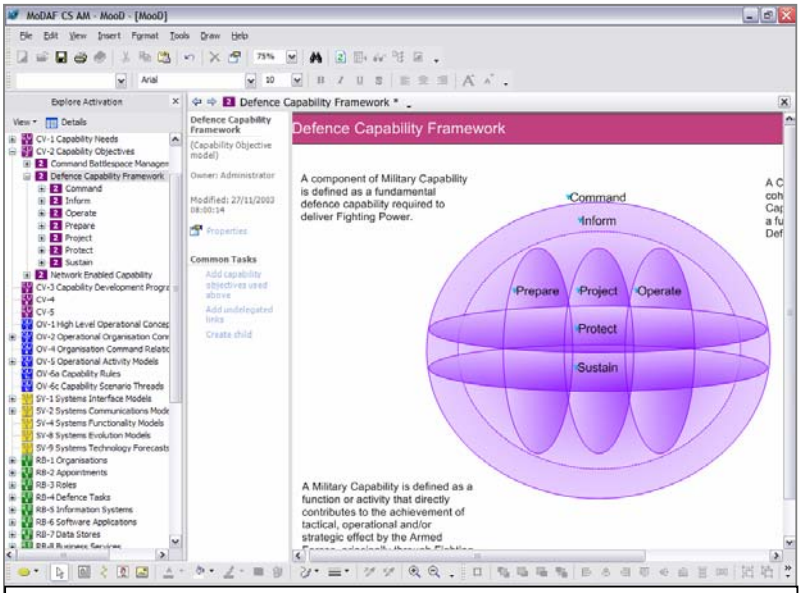


Figure 6. Overview of the Defence Capability Framework

Methodology support for early engagement and structuring can include a range of approaches, including:

- Soft Systems modelling to capture high-level concepts of capability objective;
- Performance-oriented methods such as the development of frameworks to capture key effectiveness criteria and needs;
- Modelling the principles of operation that drive the rationale and begin to map against operational concept pictures.

Once we have traced into the operational concept, we can move gradually into more technical models concerning operations, mapping into Systems and Technical Standards models following the DoD AF methodology.

The Air Manoeuvre C2 work has engaged a range of stakeholders in the process, principally capability owners and those experienced in operations, alongside those with experience in the kinds of systems that might be integrated into these operations. The method uses concepts appropriate to this stage of the dialogue, allowing assumptions from past practice to be challenged, while best practice knowledge from the past is carried forward.

The process of matching need against current capability poses questions such as, "Do we need to reconfigure current capability to match new needs?" and, by implication, "What capabilities do we currently have that are not matching needs?". For example, in Air Manoeuvre C2 the availability of information is a critical aspect of effectiveness, but to different degrees in different contexts. Expressing this need, and being able to map into the various configurations and scenarios that satisfy this need, requires the ability to move seamlessly from, for example, metrics and effectiveness assertions to the scenarios and configurations of military capability that support and generate these metrics.

4.3 Integration across the different perspectives required at each stage

At each stage in the CADMID process, we find a need for a variety of methodologies and notations, and creating and sustaining coherence across this environment requires more than just traceability. We need the ability to reference across the whole range of perspectives, to achieve optimal use of existing resources within the range of contexts that exist.

Put another way, we need the ability for "contextual re-use" wherein the actual details of how something works is dependent upon the situation in which it is being applied.

In Air Manoeuvre C2, for example, technical notations such as event sequence notations (as shown in the "Detailed Operational View" in Figure 2) are required to capture exact behaviours across logistics supply chains; equally, less technical notations are required that express the roles or competence models for the organisations that are involved across this supply chain, that might in turn be associated with performance measures or effectiveness envelopes in particular situations. The meta model that the team has been developing alongside other initiatives in the UK includes the elements shown in Figure 7.

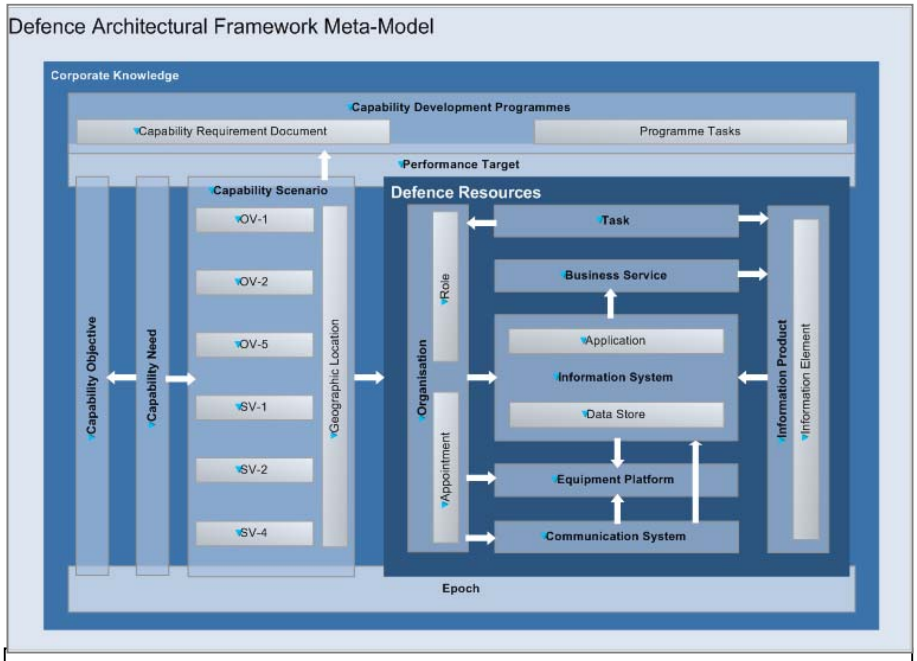


Figure 7. Elements of the methodology meta-model: components and summary

Support is given for the core technical notations of DoD AF, but these are simply different views onto the same elements described in other perspectives, where they pick up additional references and definition. Process, risk, organisation and effectiveness are all teased apart, but put back together through referencing and contextual reuse.

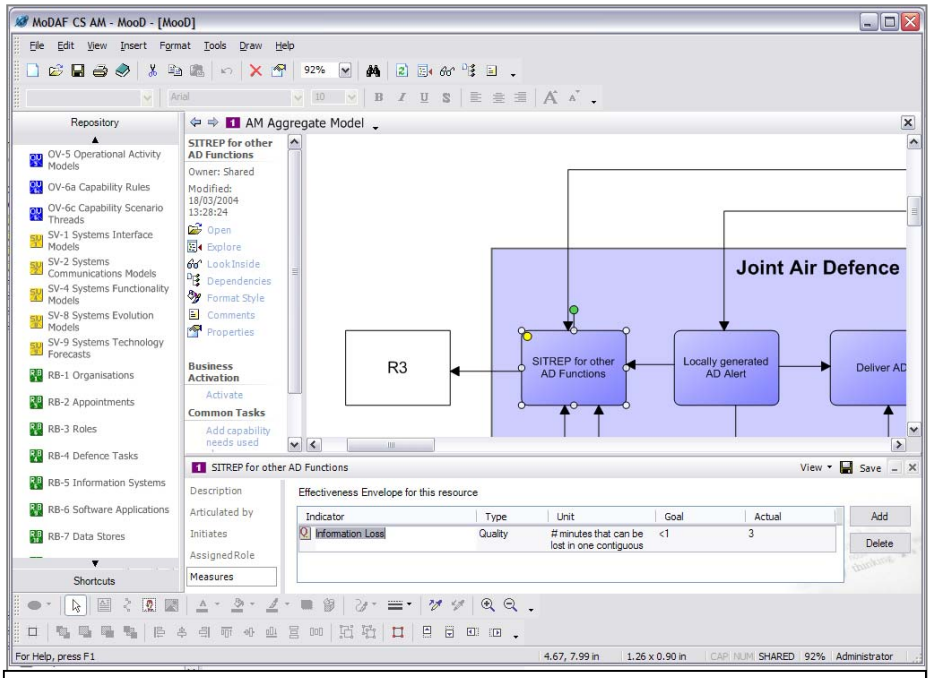


Figure 8. Fragment of an operational view, with associated performance measure.

In Air Manoeuvre C2, the model layer that allows a coherent enterprise representation comprising multiple integrated elements can be seen and constructed from different viewpoints – diagrams provide a way of reusing and configuring defined, tested components to meet a particular need. So, an operational view (an OV-2) model **(**see Figure 8**)** pulls together a set of organisations, and is related to a collection of performance measures that appear in their own right.

Applying this Blueprint to a variety of significant situations in the UK defence sector has resulted in the creation of visual and formal requirements models closely consistent with DoD AF, and also with the original motivation for Enterprise Architecture. In all cases, the models have been created interactively with key stakeholders, motivated by the requirement for a coherent definition of military capability aligned with information and knowledge sources. The approach recognises that a notation and toolset has to be functionally fit for purpose, but also supportive of the process itself – accessible to all significant stakeholders, and able to address non-technical as well as technical concepts and activities.

5. Summary and Conclusions

This paper has addressed areas in which improvements are needed to address the performance of capability development within defence. Focusing upon the need for more effective approaches to requirements modelling and stakeholder participation within large programmes, we have reflected upon the reasons behind current difficulties, and described approaches whereby these are currently being combated through our development programmes. We have illustrated how some of these proposed approaches are being pursued within the British Army.

In conclusion, we argue that:

- To address the issues of risk, cost and time over-run within defence acquisition, we need methodologies that better support the early stages of the process. In particular, this support needs to encourage and enable all of the relevant stakeholders to engage constructively during the early stages, in such a way that they are able to continue their participation in a coherent manner onwards throughout the life of a programme.

- This means that owners of capability requirements are able to, and are expected to, take a more active and responsible role in requirement definition and in ensuring alignment of solution to this requirement. Also that decision makers throughout the process are able to make sense of their complex and adaptive environment.

- Which in turn requires principles, notations, methodologies and tools that are rich enough to express in a coherent and integrated manner the perspectives of all of these stakeholders. By creating clarity and revealing insights, options and implications, the wider community of stakeholders can be motivated to perform to the benefit of the programme objectives.

The concept of enterprise architecture is the key to this, but the approach adopted must provide the required breadth, integrity and accessibility to enable all stakeholders to engage and remain engaged in an active manner, across the range of perspectives demanded by each stage in the acquisition process. This is consistent with the original vision of enterprise architecture, but at odds with the primarily technical approach promoted through DoD AF. Through developing improved methodologies and architecture frameworks, and applying these to capability development within UK defence, we contribute towards delivering the benefits envisaged by the Strategic Defence Review.

Hi-Q Systems
Making Sense of Complexity

THE Salamander ORGANIZATION

‘Improving requirement modelling and traceability within an enterprise architecture framework: Methods, Blueprints and Experiences’

Col Jeremy Barrett UKAR	Hi-Q Systems Ltd
Dr Dick Whittington	The Salamander Organisation
Prof Keith Hartley	Centre for Defence Economics, University of York
Maj Toby Sumpter UKA	Directorate of Command and Battlespace Management (Army)
Dr Simon Smith	The Salamander Organisation

‘Improving requirement modelling and traceability within an enterprise architecture framework: Methods, Blueprints and Experiences’

Challenging the DoD AF paradigm

NAO 'Major Projects Report 2003'

Reports:

- Improvements in gross time and cost overrun
- Encouraging signs of innovative relationships with industry …

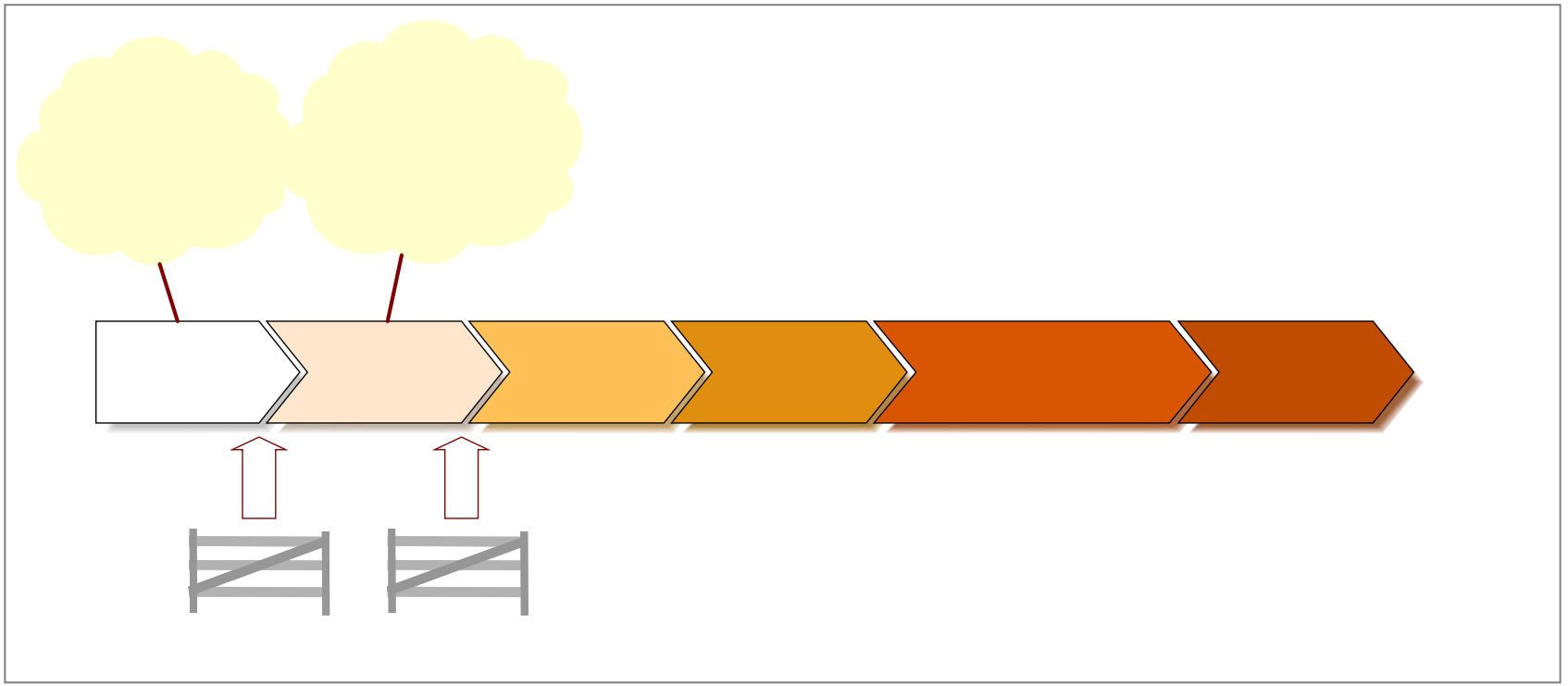
But …

there is more to do

'More needs to be done'

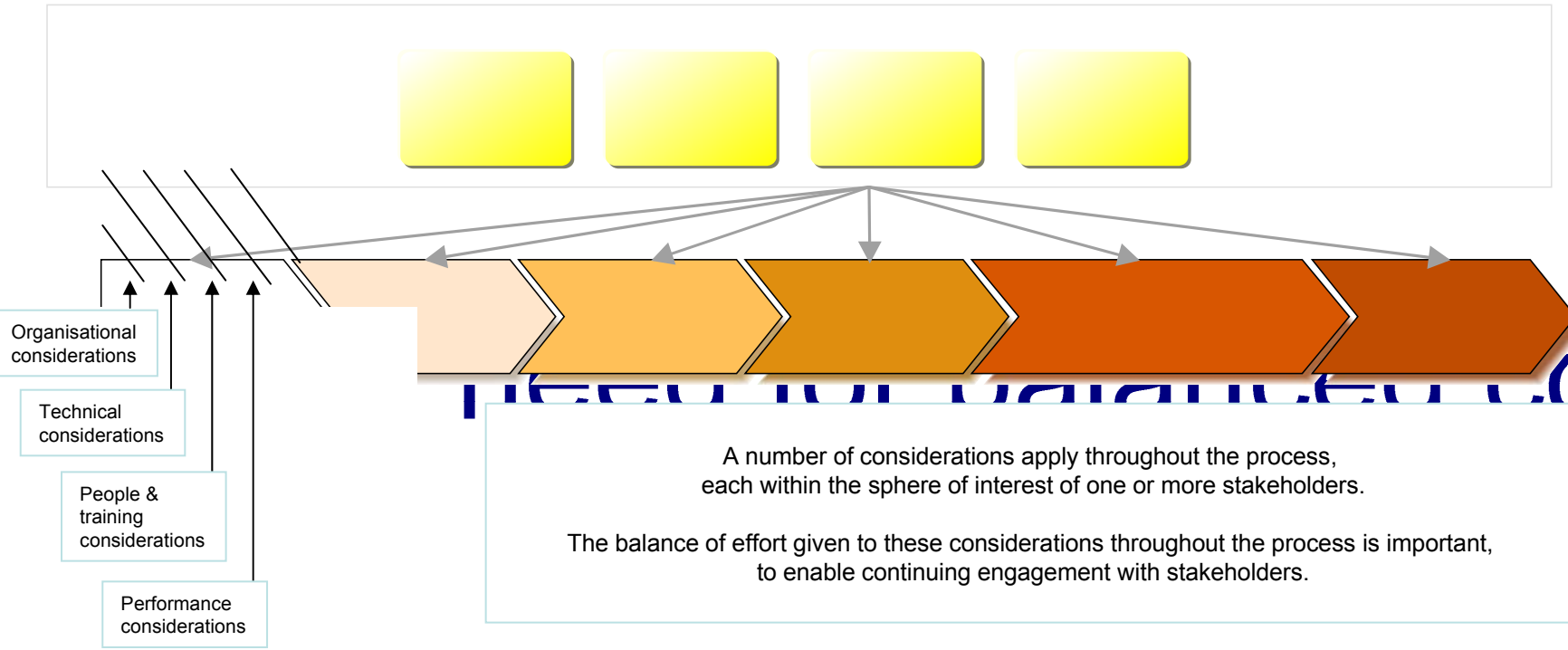
- Methodologies, architecture and governance frameworks for:
  - Defining and managing requirements
  - De-risking development through increased coherence, integration and communication
- Engaging, motivating and improving the performance of stakeholders in the acquisition community through:
  - Transparency
  - Incentive
  - Communication

SMART Acquisition



T ed to define capabi

To encourage a mind-set that is unencumbe
developments, it is important that the initial C
explore outside the realm of traditional meth



Need for balanced considerations

A number of considerations apply throughout the process,
each within the sphere of interest of one or more stakeholders.

The balance of effort given to these considerations throughout the process is important,
to enable continuing engagement with stakeholders.

Stakeholders:

What needs to be done?

- Action at both the business and technical level
- An increased awareness that these views are closely related

Challenges

- Creating a common language to enable the effective engagement of stakeholders
- The development of a common approach to their description with tools in support

Hi-Q Systems
Making Sense of Complexity

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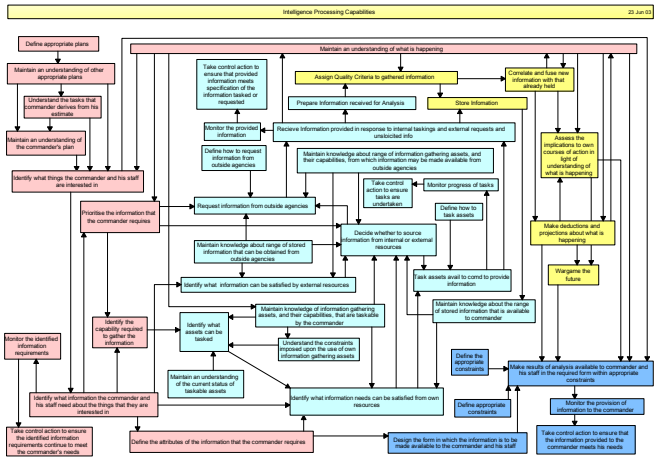
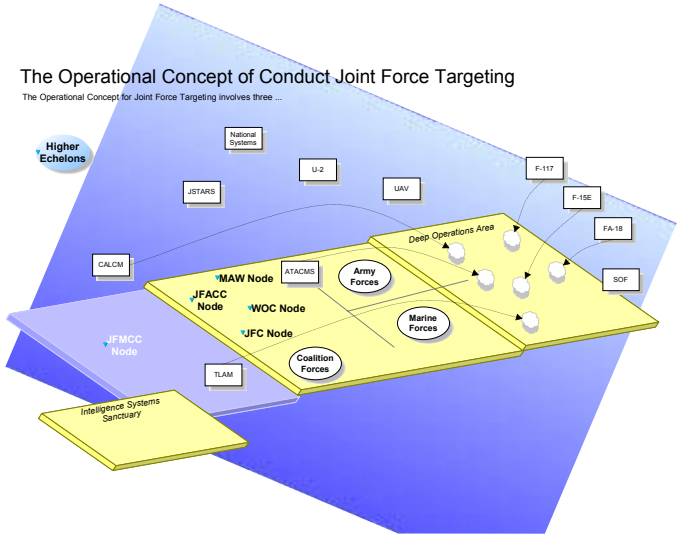
High-level Operational View

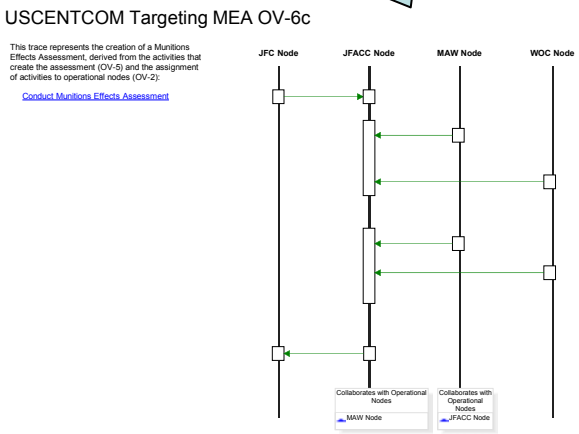
Capability Requirement





Viewed at the 60,000 foot perspective, we are aware of the overall context of the requirement, and the principal participating components

Viewed at the 6 foot perspective, we are able to analyse the specific interactions required between specific components in order to achieve connectivity and synchronisation



The challenge is to ensure integrity, breadth and completeness of these views, to inform and connect a broad community of stakeholders actively throughout the programme

Detailed Operational View

Challenges

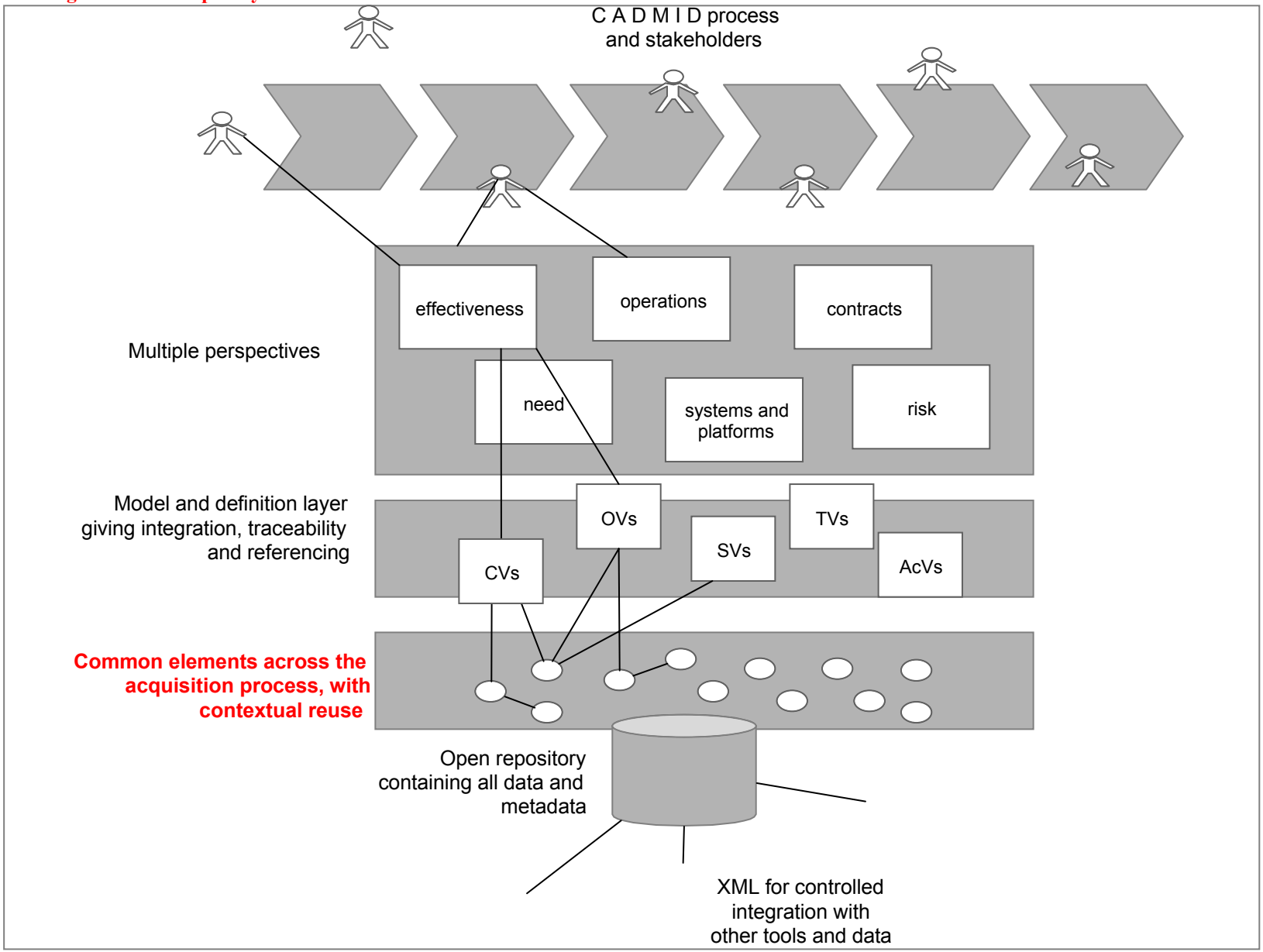
- Creating a common language to enable the effective engagement of stakeholders
- The development of a common approach to their description with tools in support
- Managing communication and relationships
- Managing performance and achievement

Shortcomings in Current Practice

- Requirements definition is conditioned by current and past assumptions
- The coverage of key areas within acquisition stages is often unbalanced
- Application of enterprise architecture methodology over-emphasises the technical
- The social and economic realities are often neglected

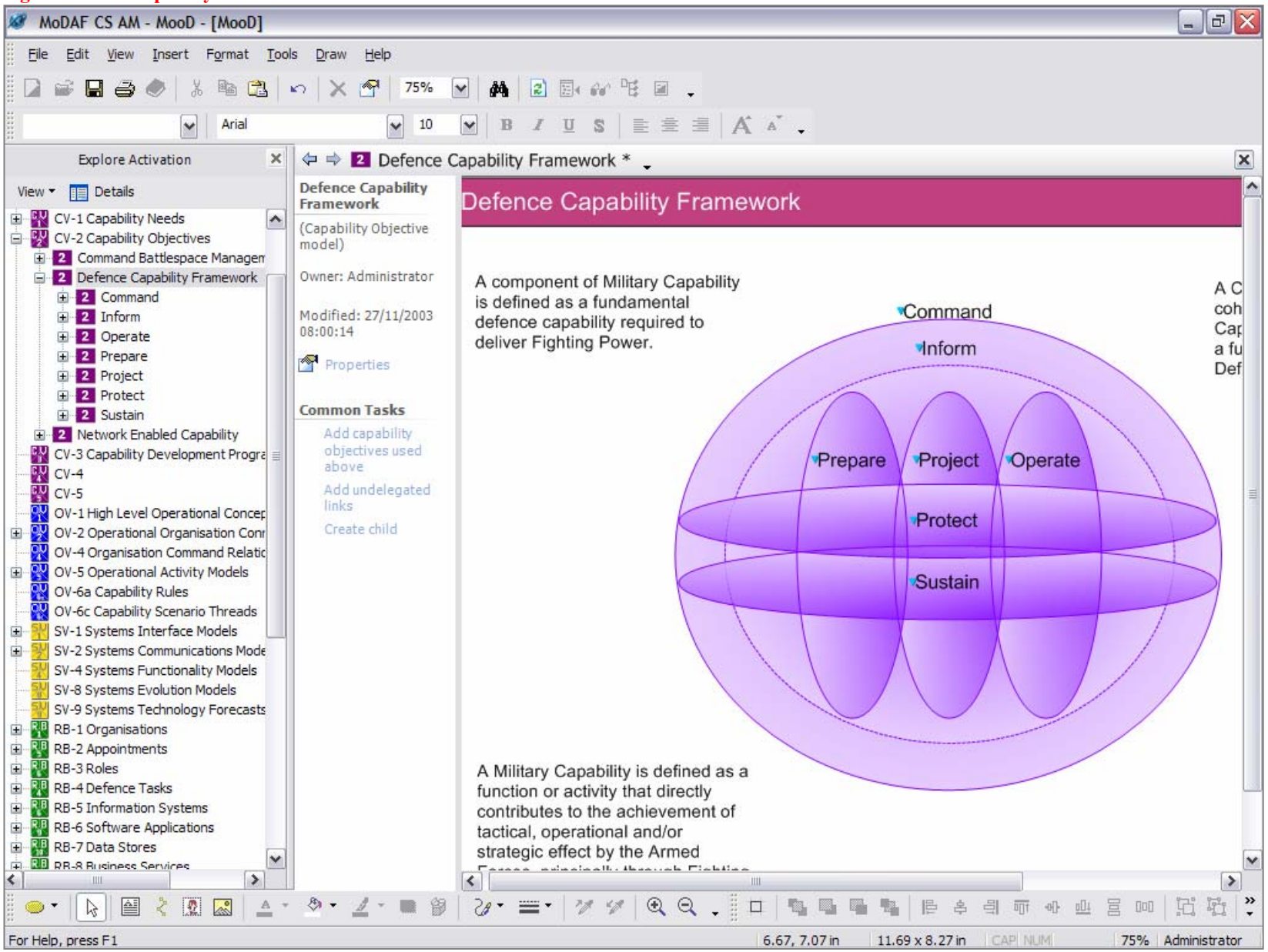
Addressing the challenge

- Principles and ideas


C A D M I D process
and stakeholders
Multiple perspectives
effectiveness
operations
contracts
need
systems and
platforms
risk
Model and definition layer
giving integration, traceability
and referencing
OVs
TVs
SVs
CVs
AcVs
Common elements across the
acquisition process, with
contextual reuse
Open repository
containing all data and
metadata
XML for controlled
integration with
other tools and data

Addressing the challenge

- Principles and ideas
- Support throughout the acquisition process not just at development and manufacture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CV-2 Capability Objectives
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CV-3 Capability Development Progra
CV-4
CV-5
OV-1 High Level Operational Concep
OV-2 Operational Organisation Conr
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OV-5 Operational Activity Models
OV-6a Capability Rules
OV-6c Capability Scenario Threads
SV-1 Systems Interface Models
SV-2 Systems Communications Mode
SV-4 Systems Functionality Models
SV-8 Systems Evolution Models
SV-9 Systems Technology Forecasts
RB-1 Organisations
RB-2 Appointments
RB-3 Roles
RB-4 Defence Tasks
RB-5 Information Systems
RB-6 Software Applications
RB-7 Data Stores
Defence Capability Framework *
Defence Capability Framework
(Capability Objective model)
Owner: Administrator
Modified: 27/11/2003 08:00:14
Properties
Common Tasks
Add capability objectives used above
Add undelegated links
Create child
Defence Capability Framework
A component of Military Capability is defined as a fundamental defence capability required to deliver Fighting Power.
Command
Inform
Prepare
Project
Operate
Protect
Sustain
A Military Capability is defined as a function or activity that directly contributes to the achievement of tactical, operational and/or strategic effect by the Armed
For Help, press F1
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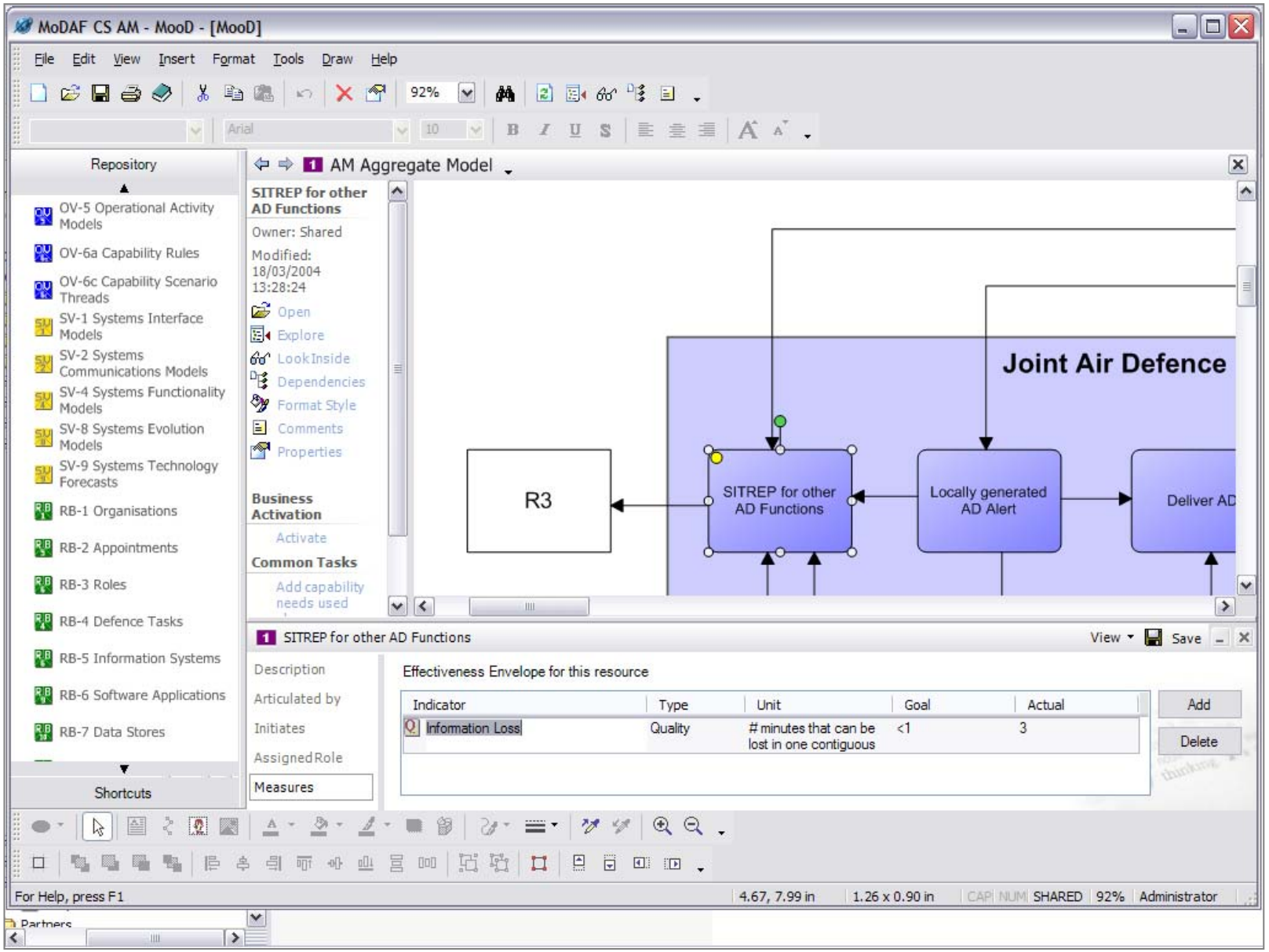
Administrator

Addressing the challenge

- Principles and ideas
- Support throughout the acquisition process not just at development and manufacture
- Integration across the different perspectives required at each stage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Repository
OV-5 Operational Activity Models
OV-6a Capability Rules
OV-6c Capability Scenario Threads
SV-1 Systems Interface Models
SV-2 Systems Communications Models
SV-4 Systems Functionality Models
SV-8 Systems Evolution Models
SV-9 Systems Technology Forecasts
RB-1 Organisations
RB-2 Appointments
RB-3 Roles
RB-4 Defence Tasks
RB-5 Information Systems
RB-6 Software Applications
RB-7 Data Stores
Shortcuts
AM Aggregate Model
SITREP for other AD Functions
Owner: Shared
Modified: 18/03/2004 13:28:24
Open
Explore
LookInside
Dependencies
Format Style
Comments
Properties
Business Activation
Activate
Common Tasks
Add capability needs used
Joint Air Defence
R3
SITREP for other AD Functions
Locally generated AD Alert
Deliver AD
SITREP for other AD Functions
View
Save
Description
Articulated by
Initiates
Assigned Role
Measures
Effectiveness Envelope for this resource
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Type
Unit
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CAP NUM SHARED 92% Administrator

Conclusions

- To address the issues of risk, cost and time over-run, we need methodologies that better support the early stages of the process
- Owners of capability requirement need to be able to (and be expected to) take a more active and responsible role in requirement definition and solution alignment
- Decision makers throughout the process must be able to make sense of their complex adaptive environment
- This requires principles, notations, methodologies and tools that are rich enough to express in a coherent and integrated manner the perspectives of all the stakeholders …